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Econometric Estimates of Army Retention: Zones A, B, C, D and Retirement-Eligible, 1990 – 2004

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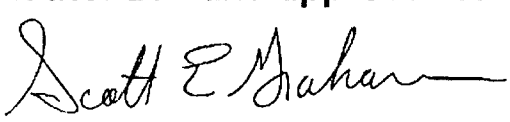

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Efficient allocation of reenlistment bonuses requires the ability to estimate the effect that the bonus will have on reenlistments in an occupational specialty. Previous research, conducted in developing the SRB Management System, estimated the effects of SRB on Zone A, B and C reenlistment decisions made between FY1990 and FY2000. In this analysis, we extend the years analyzed to include FY2001 through FY2004. The additional years of data include Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). We tested the ability of the existing model to predict reenlistment decision-making post-FY2000. To improve fit, we generated new econometric estimates by MOS, CMF and Zone using the more recent years of data, and conducted out-of-sample prediction testing to confirm the validity of the updated model.

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ECONOMETRIC ESTIMATES OF ARMY RETENTION ZONES A, B, C, D AND RETIREMENT-ELIGIBLE, 1990 – 2004

CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Efficient allocation of reenlistment bonuses requires the ability to estimate the effect that the bonus will have on reenlistments in an occupational specialty. Previous research, conducted in 2002 and 2005, (both reported in Hogan et al., 2005)[1], estimated the effects of the Selective Reenlistment Bonus (SRB) Program on Zone A (17 months to 6 years of active service), Zone B (6 to 10 years of service) and Zone C (10 to 14 years of service) reenlistment decisions made between FY1990 and FY2000. In this analysis, we extend the years analyzed to include FY2001 through FY2004. The additional years of data include Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). We tested the ability of the existing model to predict reenlistment decision-making post-FY2000. To improve fit, we generated new econometric estimates by military occupational specialty (MOS), career management field (CMF) and Zone using the more recent years of data, and conducted out-of-sample prediction testing to confirm the validity of the updated model. We then discuss the implications of the estimates for the implementation of the SRB Management System.

This study expands on the existing reenlistment models by exploring the potential impact of bonuses on Soldiers in Zone D—those who have 15 through 19 years of service—as well as retirement-eligible personnel. During the period of our data, the Army has offered SRB after the second reenlistment point only very rarely and, until recently, there has been little reason to consider bonuses for Soldiers in Zone D. The opportunity cost of leaving the Army before the 20 year mark, once one is beyond the 10-12 years of service point, is so high that an SRB would have a negligible impact on the decision. Nor has there been an interest in analyzing the retention decisions of retirement-eligible Soldiers, who are more likely to be motivated by taste for service or other non-monetary, difficult-to-measure considerations. However, the Army has become interested in expanding monetary incentives to senior Soldiers working in certain high-demand occupations such as Special Forces.[2] These experienced personnel are often in great demand by the civilian sector, including some who are sought by industry to provide security support in Iraq.

In order to incorporate the most recent data and examine the reenlistment decisions of Zone D + Soldiers (i.e., Zone D plus retirement-eligible), we had to consider several important policy changes. The Army began applying Stop Loss policy in FY02—the first time since the Gulf War in 1991. Soldiers under Stop Loss are not eligible to separate, necessitating adjustments to the data.

Additionally, the vast majority of Zones C and D reenlistments are in the Indefinite Reenlistment Program (IRP), which began in October 1998. Indefinite Reenlistments are not associated with contracts of a specific length. Similar to officers, IRP Soldiers can separate at any time (unless they are deployed or have accepted deployment orders). Once in the IRP, Soldiers can serve without additional approval or formal reenlistment until the retention control point for their grade. The policy necessitated adjustments to the model for Zones C and D. By

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[1] See Hogan, P. F., Espinosa, J., Mackin, P., & Greenston, P. (2005). A Model of Army Reenlistment Behavior: Estimates of the Effects of Army's Selective Reenlistment Bonus on Retention by Occupation (SR2005-02). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. The 2005 results are also reproduced in Tsui, et al. (2007).

[2] The other uniformed services are following suit. The Navy has started offering Zone D retention bonuses to some nuclear-qualified sailors (Navy Personnel Command, NAVADMIN 125/06, May 2006).

Army policy, SRB is not offered for IRP reenlistments without approval from HQDA.[3] However, from a force management perspective, it is useful to understand the impact of monetary incentives on retention behavior.[4]

II. DATA AND VARIABLE CONSTRUCTION

The Army provided data on reenlistment decisions made from FY1990 through FY2004. We received annual extracts of the Enlisted Master File (EMF) for September 1989 through September 2000 together with extracts of the Enlisted Loss File. Data for FY2001-FY2004 were drawn exclusively from the EMF, using quarterly extracts to identify leavers. We used these data to identify Soldiers eligible to make stay/leave decisions, characterize their decisions, and generate explanatory variables for the estimation. We generated individual records for each reenlistment decision observed in the analysis period. In addition, we calculated annualized cost of leaving (ACOL) values for each decision-maker. As in previous analyses, ACOL is expressed in 1995 dollars.

The models capture the probability that a Soldier will reenlist, conditional on his or her ACOL and demographic, educational and career characteristics. For an extensive discussion of the Annualized Cost of Leaving (ACOL) framework, construction of the ACOL variable, and other variables used in the model, see Hogan, et al. (2005).[5] Our construction of the dependent variable—the stay-leave decision indicator--took into consideration the Indefinite Reenlistment Program and Stop Loss.

A. Indefinite Reenlistment Program

Starting in October 1998 (FY99), reenlisting Soldiers in grade E6 or higher, who have completed at least 10 years of service on the date of reenlistment, enter the Indefinite Reenlistment Program.[6] The policy applies to the vast majority of Zone C, Zone D and retirement-eligible decision-makers who entered the reenlistment window in FY98 and later. On average, between FY98 and FY04, 76 percent of Zone C Soldiers eligible to separate from the Army were in the IRP.[7] Although Soldiers serving on indefinite enlistments are not eligible to receive SRB without approval from HQDA, we included them in the analysis in order to understand the effect of pay for Zone C and beyond. The ACOL parameter can be used to compute the effect of additional monetary incentives on retention should the Army need to expand bonus programs for senior personnel.

Once in the program, Soldiers can separate at any time, and we included them as eligible decision-makers every year. For a given year's decision the dependent variable was set equal to 1 if the Soldier appeared in the data the following year. If the Soldier was not in the following year's file, the decision was characterized as a loss and the dependent variable was

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[3] See AR 601-280, *Army Retention Program*, 31 January 2006, paragraph. 3-16.

[4] Another important, recent policy change permits any deployed Soldier to reenlist; Soldiers no longer need to wait until their reenlistment window opens up. This policy took effect in January, 2005, after the period covered by our data.

[5] That paper combines the results from an earlier 2002 analysis as well as a later revision during which explanatory variables were added to the model.

[6] See AR 601-280, *Army Retention Program*, 31 January 2006.

[7] Our Zone C analysis file includes individuals who were not in the IRP, as well. Generally, this group consists of E5s and below in Zone C, but there are many decision-makers who meet the criteria for IRP but who are on record as not in the program.

set equal to zero. The decision is represented in the data for every year that the Soldier is in the IRP in the relevant Zone.

Because Soldiers may reenlist up to 12 months prior to their expiration of term of service (ETS) date, IRP may apply to Soldiers who became eligible to reenlist in FY98. For Zones C and D, we limited the analysis to decisions made in FY98 and later.

B. Stop Loss

The Army imposed Stop Loss on selected skills and units starting in FY02. Soldiers under Stop Loss are not eligible to separate and we attempted to eliminate them from the database. It was often possible to eliminate Stop Loss affected Soldiers based on their ETS. For example, the Army changed the ETS of Soldiers affected by the skill-based stop losses of FY02 to 24 December, 2031 in the Total Army Personnel Database (TAPDB). These ETS were flagged and eliminated. However, our dataset did not allow us to identify Soldiers affected by unit-based Stop Loss, which began in FY03. Affected Soldiers would have been categorized as extensions in FY03 and FY04.[8]

Table 1. Army Stop Loss Timeline[9]

Date	Action
30 Nov 2001	Stop Loss 1 – Limited to Active Army (AA)
27 Dec 2001	Stop Loss 2 - Expanded to include Ready Reserve (RR) and additional skills and specialties for both AA and RR
8 Feb 2002	Stop Loss 3 – Expanded to include additional MOS, skills and specialties for AA and RR
4 Jun 2002	Stop Loss 4 - Partially lifted Stop Loss for skills and specialties in SL 1-3, included additional skills and specialties for AA and RR
22 Dec 2002	Stop Move for selected Active Component (AC) units in CENTCOM AOR (Central Command Area of Responsibility)
14 Feb 2003	AC unit-based Stop Loss – Selected units in the CENTCOM AOR (Central Command Area of Responsibility)
01 Jul 2003	Skill-based Stop Loss partially lifted for certain skills and specialties
13 Nov 2003	AA unit Stop Loss for deployed OCONUS in support of OEF/OIF. Skill-based Stop Loss lifted.

C. Dependent variable

For Zones A and B, we constructed a traditional, ETS-based decision indicator. A Soldier was designated as a reenlistee if he or she acquired a new enlistment date showing at least 24

[8] Unit-based Stop Loss barred a Soldier from leaving during a deployment, or in the 90 days leading up to or following a deployment. If a typical deployment lasts 1 year, the most a Soldier's ETS would change would be 18 months. We categorized any change in ETS of less than 24 months as an extension.

[9] "Stop Loss" means that the soldier may not choose to leave at his or her ETS. This window for a voluntary decision to leave the Army is delayed by the "Stop Loss" policy. "Stop Move" means that the member will remain at the current station or deployment area rather than rotate to another location.

months of additional obligation some time during the ETS window. Soldiers were characterized as losses if their loss records showed a transaction date within 90 days of ETS (FY 1990-2000 data) or if they were missing from subsequent years' files (FY 2001-2004 data). We set the dependent variable to zero if the Soldier decided to leave the Army.[10] Soldiers who separated involuntarily or left more than 90 days prior to their ETS were censored from the final data.

Thus, higher SRBs, through the effect on ACOL, are predicted to increase reenlistment by inducing Soldiers to sign up for a commitment of at least 3 years, the minimum required for receipt of an SRB, instead of leaving. Extensions—signaled by a change in ETS of less than 24 months[11]—were dropped from the regressions, for two reasons. First, a newly imposed unit-based Stop Loss is observationally equivalent to an extension in our database. Second, extensions were excluded from the prior analyses. Including extensions in the model (in the denominator) had a negligible impact on the ACOL coefficients.

The IRP suggests a different approach for Zones C and D+. All decision-makers were treated as making annual decisions, so the distinction between reenlistment and extension was not relevant. We set the dependent variable equal to one for a given year if the Soldier was in the database the following year, and zero otherwise. We address Zone C and D models in greater detail in subsequent sections.

D. Reenlistment trends

Table 2 reports reenlistment rates by fiscal year of decision. For Zone D, we report only the means starting in FY98, the earliest that decision-makers would have been affected by the IRP. Reenlistment rates tended to be lower in the period of the new data, 2001-2004, than in previous years.[12] There is a spike in FY03, perhaps in association with the start of OEF in March. Because we attempted to eliminate Soldiers under Stop Loss from the database, we interpret this spike as reflecting voluntary decisions to reenlist. The reenlistment rate returned to its previous level in FY04.

III. MODEL UPDATE

Table 3 presents the predicted probabilities of reenlistment when the parameters from the previous model are used to forecast 2001-2004 reenlistment rates. The predicted value is the mean probability generated by the model for the observations in a 5% hold-out sample. Because of the policy and operational changes characteristic of the post-9/11 period it is not surprising to find substantial differences between actual and predicted values. The residuals

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[10] Another approach is to treat the decision to reenlist or extend as endogenous to the SRB program, and code the dependent value as zero in the case of extensions. In practice, there was little difference in the regression coefficient estimates that included extensions and those that dropped them. We chose to present the models without extensions because it was the approach taken in prior analyses (Hogan et al. 2005) and because stop losses in 2003-2004 are observationally identical to extensions in our database.

[11] Reenlistment periods are for 2, 3, 4, 5 or 6 years, or for an indefinite period. Soldiers who opt to extend an existing contract may do so for a period of up to 23 months (Army Regulation 601-280, *Army Retention Program*, 31 January 2006).

[12] A shift variable is introduced in the model estimation (see Tables 4 and 5) to account for this.

Table 2. Reenlistment Rates by Fiscal Year of Decision Eligibility and Zone[13]

Fiscal Year	Reenlistment Rate						
	All Zones	Zone A	Zone B	Zone C	Post-Zone C All YOS	Zone D--Not Retirement Eligible	Retirement Eligible
1990	57.9%	40.6%	83.1%	93.4%			
1991	67.5%	50.3%	83.5%	93.6%			
1992	50.4%	37.4%	64.3%	76.5%			
1993	59.1%	48.6%	70.2%	89.9%			
1994	60.6%	50.1%	69.6%	88.0%			
1995	61.5%	47.1%	69.8%	90.9%			
1996	58.8%	47.1%	63.9%	87.8%			
1997	66.4%	55.8%	72.1%	88.1%			
1998	73.4%	54.4%	73.0%	96.1%	79.7%	88.2%	57.5%
1999	72.7%	53.3%	73.4%	95.5%	85.2%	93.4%	60.4%
2000	72.6%	54.8%	70.2%	94.1%	87.3%	94.3%	63.4%
2001	56.4%	37.4%	58.2%	87.2%	83.6%	90.4%	67.7%
2002	58.6%	37.0%	63.5%	90.5%	84.8%	93.0%	70.8%
2003	66.7%	46.8%	67.7%	93.8%	86.0%	94.3%	73.9%
2004	58.1%	37.8%	61.7%	91.6%	82.5%	93.6%	67.8%

generated for Zone A for the years 1990-2000 averaged -0.17 percentage points (Hogan, et al. 2005); applying the same model to the more recent years yields an average prediction error of +1.3 points. Can incorporating more recent years of data into the underlying model improve forecasting?

Table 3. Predicting FY01-04 Reenlistment Rates with FY90-00 Model

	Zone A Sample			Zone B Sample		
Year	Predicted	Actual*	Residual (points)	Predicted	Actual*	Residual (points)
2001	44.7%	37.9%	6.7	64.8%	57.8%	7.0
2002	39.2%	36.8%	2.4	61.4%	62.5%	-1.1
2003	38.3%	46.0%	-7.7	65.3%	68.7%	-3.4
2004	40.8%	37.3%	3.5	66.7%	61.4%	5.2

**Actual values may differ slightly from those shown in Table 2 due to sample selection procedures.*

We updated the model for Zones A and B to include the years FY90-FY04, including the explanatory variables from previous models, but adding some year and policy dummy variables. For Zone C, we modified the specification in order to reflect the IRP. Army-wide estimates are presented below, as are results for the 20 largest MOS and CMF.

[13] Zone A reenlistments take place after completion of between 1 and 5 years of service (that is, starting in the second year); the Zone B window is 6-10 completed years of service; Zone C reenlistees have completed 11 through 13 years of service; "post-Zone C" refers to Soldiers who have completed at least 14 years of service. Retirement eligibles have completed at least 19 years of service and are in their 20th year or beyond.

We calculated the responsiveness of the reenlistment rate to the change in SRB, based on the following equation: $$\frac{\partial R}{\partial SRB} = \frac{\partial R}{\partial ACOL} * \frac{\partial ACOL}{\partial SRB}.$$

R is the reenlistment rate, *SRB* is the Selective Reenlistment Bonus award level, and *ACOL* is the annualized cost of leaving. The first term is the marginal effect of ACOL on reenlistment, derived from the LOGIT coefficient in the estimated equation. Note that

$$\frac{\partial R}{\partial ACOL} = R * (1 - R) * B,$$

where R is the mean reenlistment rate and B is the estimated coefficient for the ACOL variable. The second term is the impact of a one-level increase in SRB on ACOL. The one-level SRB increase was in relation to the modal SRB in a Zone. For the MOS and CMF-level estimates by Zone, the SRB increase was in relation to the modal SRB for the MOS by Zone or CMF by Zone.

A. All-Army Results for Zones A and B

Table 4 shows the results of logit estimation using the updated, Army-wide dataset, which includes all MOS and CMF. Pooling the FY01-04 data with that of prior year has some effect on coefficient values in comparison to the models that use only FY90-00 data (Hogan et al. 2005).[14] For the most part, the signs and significance levels are preserved (although some of the education variables in Zone B are no longer significant).

The impact of a one-level increase in SRB is lower when recent years of data are incorporated into the model. We calculate an increase of 3.58 percentage points, compared to an increase of 6.4 points reported in Hogan et al (2005).

The marginal effects reported in table 4 imply that Zone B decision-makers are slightly more responsive to a 1-level increase in SRB than are Soldiers in Zone A, while previous studies have found SRB to have its greatest impact on Zone A. Note, however, that the ACOL coefficient and marginal effects show that Zone A decision-makers remain more responsive to monetary incentives of a given amount. Our result arises because the average basic pay is higher in Zone B, so that a one-level increase in SRB translates into a greater dollar amount than does a one-level increase offered to Zone A.

The "targeted" SRB (TSRB) program was instituted to provide an incentive for those in a particular MOS, ASI (Additional Skill Identifier) and SQI (Special Qualifications Identifier) to reenlist for a position at a specific unit or location. The purpose of the TSRB is to channel qualified Soldiers into particular positions at locations that are difficult to fill.

[14] We also experimented with excluding the FY90-00 data and limiting the analysis to the most recent years; however, the results were substantially improved by using all available years of data.

Table 4. Logit Estimates and Impact of 1-Level Increase in SRB: FY90-FY04

	Zone A (N=728,601)				Zone B (N=372,179)			
Variable	**Coefficient**	**Marginal Effect**	**SE**	**P-value**	**Coefficient**	**Marginal Effect**	**SE**	**P-value**
Intercept	-1.756	--	0.0468	<.0001	-1.302	--	0.0584	<.0001
ACOL	0.000216	0.00005	0.000004	<.0001	0.000189	0.00004	0.000004	<.0001
Decision in FY01-FY04	-1.181	-0.293	0.016	<.0001	-1.041	-0.220	0.019	<.0001
TSRB FY99-FY00	1.656	0.411	0.018	<.0001	1.162	0.246	0.023	<.0001
Unemployment Rate	0.093	0.023	0.004	<.0001	0.103	0.022	0.006	<.0001
AFQT	-0.006	-0.002	0.000	<.0001	-0.003	-0.001	0.000	<.0001
Female	0.209	0.052	0.007	<.0001	0.020	0.004	0.011	0.0721
Non-white	0.517	0.128	0.005	<.0001	0.373	0.079	0.008	<.0001
Separated	-0.082	-0.020	0.019	<.0001	-0.133	-0.028	0.017	<.0001
Single	-0.525	-0.130	0.005	<.0001	-0.194	-0.041	0.009	<.0001
GED	0.539	0.134	0.023	<.0001	-0.100	-0.021	0.030	0.0008
HS Grad	0.201	0.050	0.019	<.0001	-0.030	-0.006	0.023	0.2034
Non-HSG	0.474	0.118	0.023	<.0001	0.083	0.017	0.038	0.0312
Some College	0.211	0.052	0.020	<.0001	0.216	0.046	0.024	<.0001
Post-drawdown	0.313	0.078	0.011	<.0001	0.391	0.083	0.015	<.0001
Pre-drawdown	0.111	0.028	0.008	<.0001	1.002	0.212	0.014	<.0001
Impact of 1-Level Increase in SRB	0.0358 or 3.58 percentage points				0.0389 or 3.89 percentage points			

For those MOS that have positions included in the TSRB program, it typically means that if the eligible Soldier reenlists and agrees to serve in a specific, targeted position for the skill, the reenlistment bonus award level will be greater than it otherwise would. The TSRB typically adds 0.5-1.0 to the award multiple for the SRB. Hence, the TSRB program is a form of incentive for a voluntary assignment system in which qualified Soldiers volunteer for specific positions at specific locations.

In our data set, TSRB is included in FY 1999 and FY 2000. We do not have data regarding the assignments of Soldiers who reenlist, nor do we have information regarding the location of the positions for which the targeted SRB incentive was offered. Rather, we have only an indication that the Soldier was eligible for a targeted SRB. We include eligibility for a targeted SRB in the reenlistment equation. It is included in the analysis as an indicator variable. If an eligible Soldier was offered a TSRB, an indicator variable was set equal to 1.0. Otherwise, the TSRB indicator was set equal to zero. The TSRB program continued into FY 2001 and beyond, but changed in that it was based more on unit staffing than particular MOS positions. Because of this, we limit our analysis to FY 1999 and FY 2000.

The results in Table 4 suggest that eligibility for a TSRB had a very large effect on reenlistment probability. Taken literally, these results indicate that eligibility for a TSRB increased the probability of reenlistment by 41 percentage points at Zone A and almost 25 percentage points at Zone B. This effect, however, is much greater than one would expect based on the increased

financial incentive. An increase in the SRB award level by one would increase the probability of reenlistment by only about 4 percentage points. In fact, an increase in SRB that was due to the TSRB would probably have a smaller effect because one could only receive the increased SRB by accepting an assignment at a, presumably, less desirable location. The magnitude of the estimated TSRB effect, then, is a puzzle.[15]

B. All Army Results for Zone C

Because of the IRP program, our specification was somewhat different in Zone C than for Zones A and B. We considered two approaches. The first approach was to exclude all Soldiers in the IRP from the estimation. The rationale is that Army policy generally prohibits offering SRBs for Soldiers who, by virtue of their grade and YOS (years of service), are serving on an indefinite enlistment contract. This biases the Zone C sample to include a disproportionate number of individuals who are relatively low-graded (E5 and below) in relation to their years of service.

The second approach was to include all Zone C decision-makers, regardless of their IRP status, and to control for IRP in the estimation. From a bonus management standpoint, the advantage of this approach is that it gives policy makers the option of exploring the impact of expanding the SRB program to more senior personnel in Zone C. All decision-makers were treated as making annual decisions. We set the dependent variable equal to one for a given year if the Soldier was in the database the following year, and zero otherwise. In keeping with this approach, the Zone C estimates do not exclude extensions. This differs from the Zone A and B models, and raises the risk that the data include Soldiers under unit-based Stop Loss (whether a Stop Loss is in place or not, IRP Soldiers who are slated for deployment are not permitted to separate). For this model, we only included the years in which the IRP would have affected decisions—FY98 forward.

This model differs from that for Zones A and B in that it excludes the unemployment rate and adds an indicator variable set equal to one if the decision-maker was in the Indefinite Reenlistment Program. In addition, the TSRB dummy variable used in the Zones A and B regressions is excluded.

[15] One, purely mechanical, explanation for the large effect would be that the TSRB coding in the underlying data indicated not that the Soldier was eligible for the TSRB, but that the Soldier actually received a TSRB award. Hence, the TSRB indicator would coincide with a reenlistment. This, of course, would be a methodological error. The actual data, however, indicate that fewer than 100% of those indicated as eligible for TSRB reenlisted. In FY 1999, the data suggest that 18,545 were eligible and that 14,519 reenlisted—a rate of 78.3%. In FY 2000 the data indicate that 46,539 were eligible and that 43,121 reenlisted—a reenlistment rate of 92.7%. Hence, we cannot conclude that only those that received the TSRB were recorded as eligible in the data. Nevertheless, the observed reenlistment rates for TSRB eligibles are too high to be explained by the financial incentives. Hence, it is a puzzle.

Table 5. Logit Estimates for Zone C Annual Retention Decisions, FY98-FY04

	Zone C (N=205,598)			
Variable	**Coefficient**	**Marginal Effect**	**SE**	**P-value**
Intercept	1.317	--	0.088	<.0001
ACOL	0.000047	0.000003	0.000005	<.0001
FY01-04 Decision	-0.798	-0.051	0.025	<.0001
Indefinite Reenlistment Program	2.186	0.142	0.021	<.0001
AFQT	-0.008	-0.0005	0.0005	<.0001
Female	-0.044	-0.003	0.029	0.137
Non-white	0.315	0.020	0.021	<.0001
Separated	-0.155	-0.010	0.035	<.0001
Single	-0.120	-0.008	0.028	<.0001
GED	-0.088	-0.006	0.079	0..265
HS Grad	0.096	0.006	0.057	0.091
Non-HSG	0.541	0.035	0.073	<.0001
Some College	0.305	0.020	0.057	<.0001
Impact of 1-Level SRB Increase: 0.0047 or 0.47 percentage points				

Applying the formula above, the impact of a 1-level increase in SRB would translate into a change in annual continuation of approximately one-half of a percentage point. Note that this is substantially less than the impact of 1.8 points found in Hogan, et al. (2005) for the years before the introduction of the IRP. However, that analysis used as the dependent variable a reenlistment rate, implying a multi-year obligation. The difference in findings reflects primarily the change in the nature of the dependent variable. When the difference is accounted for, the two estimates are close.[16]

C. MOS and CMF Level Results

The tables below report the ACOL coefficients for the 20 largest CMF (table 6) and 20 largest MOS (table 8), for Zones A, B and C. In addition, we report the projected impact of a one-level increase in SRB (tables 7 and 9). For the MOS- and CMF-level ACOL estimates by Zone, we used the same model that was used to estimate the all-Army impact in each respective zone. The effect of an SRB increase was calculated in relation to the modal SRB for each MOS - Zone or CMF – Zone combination.

[16] The mean annual continuation rate for Zone C is 92.8%. In contrast, the dependent variable in the prior analysis was a reenlistment rate with a mean contract length of over 4 years, with an average value of approximately 80%. Applying the estimated impact of SRB shown in table 5 above, a 1-level increase in SRB would raise Zone C retention by 1.5 percentage points for a 4 year contract.

At both the MOS and CMF levels, most of the ACOL coefficients were of the expected sign and statistically significant (most of the negative values were not significant). Table cells are blank where the ACOL coefficient was negative or if there were too few observations to calculate the regression coefficient.

Table 6. ACOL Coefficients of 20 Largest CMF

	Zone A		Zone B		Zone C	
CMF	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**
11	0.000400	<.0001	0.000177	<.0001	0.000043	0.023
12	0.000520	<.0001	0.000196	<.0001	0.000027	0.495
13	0.000113	<.0001	0.000148	<.0001	0.000026	0.292
14	0.000475	<.0001	0.000410	<.0001	0.000057	0.149
19			0.000036	0.091	0.000009	0.753
31	0.000154	<.0001	0.000225	<.0001	0.000066	0.001
51	0.000193	<.0001	0.000238	<.0001	0.000131	0.008
54	0.000274	<.0001	0.000138	0.0008		
63	0.000106	<.0001	0.000150	<.0001	0.000038	0.032
67			0.000242	<.0001	0.000057	0.023
71	0.000324	<.0001	0.000155	<.0001	0.000074	0.000
74			0.000394	<.0001	0.000068	0.085
76	0.000606	<.0001	0.000190	<.0001		
77			0.000184	<.0001	0.000051	0.225
88	0.000150	<.0001	0.000259	<.0001	0.000052	0.050
91	0.000165	<.0001	0.000104	<.0001	0.000033	0.053
92	0.000419	<.0001	0.000171	<.0001	0.000033	0.055
95	0.000162	<.0001	0.000150	<.0001		
96	0.000112	<.0001	0.000120	<.0001		
98	0.000043	0.026	0.000129	<.0001		

Table 7. Impact of a 1-Level Increase in SRB, CMF Level Data

CMF	Zone A	Zone B	Zone C
11	0.0636	0.03570	0.0034
12	0.0840	0.03988	0.0023
13	0.0183	0.02903	0.0020
14	0.0743	0.08493	0.0053
19		0.00702	0.0007
31	0.0252	0.04942	0.0082
51	0.0316	0.04771	0.0131
54	0.0458	0.02456	
63	0.0176	0.03146	0.0044
67		0.05265	0.0063
71	0.0560	0.02643	0.0075
74		0.08846	0.0082
76	0.1036	0.03011	
77		0.03693	0.0065
88	0.0251	0.05005	0.0054
91	0.0274	0.02110	0.0041
92	0.0759	0.03473	0.0035
95	0.0292	0.03181	
96	0.0203	0.02475	
98	0.0075	0.02867	

Table 8. ACOL Coefficients of 20 Largest MOS

MOS	Zone A		Zone B		Zone C	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
11B	0.000401	<.0001	0.000185	<.0001	0.000055	0.031
11C	0.000498	<.0001	0.000162	0.0004	0.000069	0.288
11M	0.000303	<.0001	0.000103	0.0006		
12B	0.000511	<.0001	0.000200	<.0001	0.000010	0.819
13B	0.000117	<.0001	0.000172	<.0001	0.000024	0.496
19D	0.000529	<.0001	0.000141	0.0002	0.000086	0.069
19K			0.000049	0.0667		
31U	0.000760	<.0001	0.000170	<.0001	0.000111	0.009
52D	0.000265	<.0001	0.000163	<.0001	0.000113	0.110
54B	0.000284	<.0001	0.000167	<.0001		
63B	0.000223	<.0001	0.000076	0.005		
71L	0.000385	<.0001	0.000185	<.0001	0.000124	0.000
77F			0.000186	<.0001	0.000024	0.592
88M			0.000242	<.0001	0.000050	0.092
91B			-0.000070	0.011		
92A	0.000984	<.0001	0.000280	<.0001	0.000043	0.120
92G	0.000136	0.0003	0.000119	0.002		
92Y	0.000309	<.0001	0.000015	0.648	0.000036	0.239
94B	0.001170	<.0001	0.000275	<.0001		
95B	0.000200	<.0001	0.000172	<.0001	0.000037	0.131

Table 9. Impact of a 1-Level Increase in SRB, Top 20 MOS

MOS	Zone A	Zone B	Zone C
11B	0.0639	0.0362	0.0041
11C	0.0783	0.0325	0.0050
11M	0.0477	0.0194	
12B	0.0831	0.0408	0.0008
13B	0.0191	0.0316	0.0021
19D	0.0834	0.0283	0.0061
19K		0.0096	
31U	0.1232	0.0334	0.0081
52D	0.0475	0.0377	0.0129
54B	0.0474	0.0299	
63B	0.0373	0.0149	
71L	0.0620	0.0349	0.0145
77F		0.0363	0.0030
88M		0.0466	0.0056
91B		-0.0134	
92A	0.1755	0.0604	0.0057
92G	0.0245	0.0248	
92Y	0.0525	0.0028	0.0032
94B	0.1934	0.0524	--
95B	0.0360	0.0394	0.0046

D. Predictive Accuracy of Zone A, B and C Estimates

The challenges inherent in forecasting reenlistment behavior are exacerbated by rapid changes in policy and operations characteristic of the post 9/11 years. In general, forecasts are improved when they are based on as much relevant data as possible; but this need not be the case if the additional data points reflect unique, external pressures on individual behavior.

To determine the forecast accuracy of our models, and compare them to the results from using prior years' data alone to predict recent reenlistment, we created hold-out samples for each Zone for the years 2003 and 2004—the most recent two years in the database. From the hold-out data, which comprised 5% of observations from each year 2003 and 2004, we computed predicted and actual reenlistment rates, and the residual (predicted minus actual rate). See Table 10. The predicted values were computed as the average predicted probability of reenlistment. The second figure in the residual column reports the earlier-reported error (table 3) associated with using the previous model to forecast 2003 and 2004 (Hogan, et al., 2005). The results in table 10 suggest that the addition of years 2001-2004 to the model improves fit (because of the increasing importance of the IRP in the more recent data, we do not include a comparison to Zone C results from the earlier model). However, the residual for Zone A in 2003—the first year of Operation Enduring Freedom—is relatively high at 5.3 percentage points. All other residuals are relatively small.

Table 10. Predicted and Actual Values in Hold-Out Samples

	Predicted	Actual	Residual / Residual from Previous Model
	Zone A Holdout Sample		
2003	0.424	0.477	-0.053 / -.077
2004	0.387	0.389	-0.002/ .035
	Zone B Holdout Sample		
2003	0.683	0.672	0.011 / -.034
2004	0.654	0.646	0.008 / .052
	Zone C Holdout Sample		
2003	0.936	0.949	0.013
2004	0.926	0.921	-0.005
	All Zones Holdout Sample		
2003	0.635	0.637	0.002
2004	0.578	0.571	-0.007

Because the holdout sample consists of 5% of the observations in FY 2003 and FY 2004, disaggregated predictions are limited to the larger career management fields and military occupation specialties. Below, we report pooled results for 2003 and 2004, reporting results from those MOS with at least 200 decisions in the hold-out sample, between the two years.

Table 11. Predicted and actual values in hold-out samples, by MOS (N>=200)

MOS/CMF	Zone	N	Predicted	Actual	Residual
MOS 11B	A	756	0.351	0.386	-0.035
MOS 11B	B	209	0.681	0.707	-0.026
MOS 11B	C	202	0.948	0.925	0.023
MOS 92Y	A	202	0.511	0.544	-0.032
CMF 11	A	838	0.340	0.391	-0.051
CMF 11	B	237	0.669	0.712	-0.043
CMF 11	C	222	0.944	0.922	0.022
CMF 13	A	329	0.382	0.444	-0.063
CMF 19	A	245	0.379	0.420	-0.041
CMF 63	A	593	0.392	0.402	-0.010
CMF 91	A	241	0.448	0.531	-0.083
CMF 91	B	224	0.645	0.594	0.051
CMF 92	A	577	0.471	0.500	-0.029
CMF 92	B	235	0.729	0.673	0.055
CMF 92	C	205	0.913	0.862	0.051

IV. RETENTION OF ZONE D AND RETIREMENT-ELIGIBLE PERSONNEL

To explore monetary incentives beyond Zone C, we analyzed the relationship between retention and ACOL for Zone D and retirement-eligible Soldiers in all occupations. We present two models—one that is restricted to Zone D and another that also includes retirement-eligibles.

On average since FY98, over 97 percent of eligible decision-makers are in the IRP and may separate at any time, unless they are deployed. Therefore, we treat them as making a series of annual stay-leave decisions and set the dependent variable equal to 1 for a given year if the Soldier in the Army at the beginning of the year appeared in the following year's file, and zero otherwise. An individual will appear in the file every year, until he or she separates.

Table 12. Impact of ACOL on Zone D and Retirement-Eligible Personnel

	Zone D (N=276,772)				Zone D + Retirement Eligible (N=458,739)			
Variable	**Coefficient**	**Marginal Effect**	**SE**	**P-value**	**Coefficient**	**Marginal Effect**	**SE**	**P-value**
Intercept	2.688	--	0.062	<.0001	2.523	--	0.031	<.0001
ACOL	0.000019	0.0000008	0.0000005	<.0001	0.000017	0.000002	0.0000004	<.0001
FY01-04 Decision	0.197	0.008	0.020	<.0001	0.437	0.058	0.010	<.0001
1st Year Retirement-Eligible	--	--	--	--	-1.235	-0.163	0.019	<.0001
2nd Year Retirement-Eligible	--	--	--	--	-2.062	-0.273	0.018	<.0001
3rd Year Retirement-Eligible	--	--	--	--	-3.006	-0.398	0.018	<.0001
Post 3rd Year Retirement-Eligible	--	--	--	--	-2.147	-0.284	0.018	<.0001
AFQT	-0.0050	-0.0002	0.0005	<.0001	-0.00084	-0.0001	0.0002	0.0004
Female	-0.313	-0.013	0.029	<.0001	-0.231	-0.031	0.015	<.0001
Non-white	0.210	0.009	0.022	<.0001	0.213	0.028	0.011	<.0001
Separated	-0.144	-0.006	0.031	<.0001	-0.079	-0.010	0.016	<.0001
Single	-0.142	-0.006	0.039	0.0003	-0.038	-0.005	0.023	0.1065
GED	-0.814	-0.035	0.063	<.0001	-0.780	-0.103	0.033	<.0001
HS Grad	-0.583	-0.025	0.047	<.0001	-0.587	-0.078	0.022	<.0001
Non-HSG	0.381	0.016	0.062	<.0001	0.045	0.006	0.024	0.0586
Some College	0.094	0.004	0.046	0.042	-0.116	-0.015	0.020	<.0001

The results indicate that the relationship between ACOL and retention is positive and statistically significant, but small. Were the Army to increase the SRB in Zone D by one level—from 0.0 to 1.0—corresponding to a change in ACOL of about $2,400 per year—the average 1-year retention rate would increase by about 0.2 percentage points, and the 4-year retention rate (e.g., from YOS 15 to 19) would increase by 0.7 points. The effect is also small for retirement-eligible personnel, whose retention would increase by about 0.5 points for a 1-level SRB increase. Nevertheless, monetary incentives may be an attractive way to retain experienced personnel who are difficult to replace and expensive to train and develop. Future analyses may determine how to best meet skill requirements, including a comparison of the costs of retention with the costs of other mechanisms such as recruitment and retraining.

A. Retirement Eligible and Zone D Special Forces Retention

In this section, we consider the retention of Special Forces—Soldiers serving in CMF 18—who were retirement eligible or in Zone D during the FY1998 – FY2004 period. Table 13 shows the retention rates for Special Forces Soldiers in Zone D and the annual retention rate of those who were retirement eligible. The retention rates for all other Soldiers in those categories are shown for comparison.

Over the period FY 1998 through FY 2004, the Zone D retention rate for CMF 18 varied in a relatively narrow range of between 94% and 98%. This was slightly less than the variation in the rates for Zone D Soldiers not in CMF 18. Moreover, the retention rates prior to FY 2001 were, on average, about 2.7 percentage points higher than rates from FY 2001 through FY 2004. This was not the case for the rest of the Army.

The retention rates for retirement eligible Soldiers in CMF 18 ranged between 81% and 91% over the period FY 1998 through FY 2004. Retention rates prior to FY 2001 were, on average, about 3.3 percentage points higher than those from FY 2001 to FY 2004. This difference is largely the result of the FY 2004 rate that, at 81%, was the lowest observed over the period. However, the non-CMF 18 Soldiers who were retirement eligible had lower retention rates than Soldiers in CMF 18 for all years except FY 2004.

Table 13. Zone D and Retirement Eligible Retention Rates for Special Forces Soldiers and All Others

Fiscal Year	Retention Rate			
	Zone D CMF = 18	Zone D CMF not 18	Zone D + Retirement Eligible CMF = 18	Zone D + Retirement Eligible CMF not 18
1998	96.7%	90.6%	90.3%	79.4%
1999	98.1%	96.0%	89.7%	85.1%
2000	98.1%	97.4%	88.9%	87.2%
2001	94.6%	95.0%	84.0%	83.6%
2002	94.8%	96.3%	88.8%	84.6%
2003	96.0%	97.1%	90.9%	85.8%
2004	94.2%	96.6%	81.5%	82.6%

In Table 14, the results of estimating a retention model for Zone D and retirement-eligible Soldiers in CMF 18 are shown. The first model consists of Soldiers in Zone D only. The compensation variable, ACOL, is positive and statistically significant. A $10,000 annual bonus to year of service 20 increases the annual retention rate by only one percentage point. This is slightly greater than the impact for all CMFs in Zone D (0.8 points), but still very small. However, retention rates are quite high among Zone D personnel in CMF 18 so that a relatively inelastic response is not unexpected.

In the second model presented in the table, CMF 18 Soldiers in Zone D and Soldiers who were retirement eligible are pooled in a single model. The coefficient on the ACOL variable is again positive and statistically significant but the effect, which is the same as that for all retirement – eligible personnel, is small. Interestingly, the indicator variables designed to capture the effects of the first through the third year of initial retirement eligibility are negative, statistically significant, and large in absolute value.

Table 14. Impact of ACOL on Special Forces Zone D and Retirement-Eligible Personnel

	Zone D CMF = 18 (N=9,145)				Zone D + Retirement Eligible CMF = 18 (N=14,679)			
Variable	Coefficient	Marginal Effect	SE	P-value	Coefficient	Marginal Effect	SE	P-value
Intercept	3.052	--	0.389	<.0001	2.484	--	0.191	<.0001
ACOL	0.00002	0.000001	0.000003	<.0001	0.000021	0.000002	0.000003	<.0001
FY01-04 Decision	-0.940	-0.034	0.120	<.0001	0.178	0.019	0.061	0.0034
1st Year Retirement-Eligible	--	--	--	--	-1.051	-0.112	0.112	<.0001
2nd Year Retirement-Eligible	--	--	--	--	-1.449	-0.154	0.112	<.0001
3rd Year Retirement-Eligible	--	--	--	--	-2.386	-0.254	0.105	<.0001
Post 3rd Year Retirement-Eligible	--	--	--	--	-1.881	-0.200	0.108	<.0001
AFQT	-0.0058	-0.0002	0.0031	0.063	-0.0034	-0.0004	0.0014	0.017
Female	0	0	.	.	0	0	.	.
Non-white	-0.079	-0.003	0.159	0.620	0.063	0.007	0.082	0.442
Separated	-0.206	-0.008	0.181	0.255	-0.065	-0.007	0.094	0.484
Single	0.362	0.013	0.222	0.103	0.142	0.015	0.125	0.254
GED	0.688	0.025	0.426	0.107	-0.050	-0.005	0.182	0.783
HS Grad	0.521	0.019	0.295	0.078	0.103	0.011	0.130	0.427
Non-HSG	0.609	0.022	0.360	0.091	0.410	0.044	0.152	0.007
Some College	0.344	0.013	0.290	0.235	0.175	0.019	0.125	0.161

The estimates indicate that the effect of compensation on the retention behavior of Special Forces Soldiers in Zone D and those who were retirement-eligible is positive and statistically significant. However, the magnitudes of the effects are small.

V. IMPLICATIONS OF THE RESULTS FOR THE SRB MANAGEMENT SYSTEM

A. "Baseline" Method and Estimating Equation Method

Within the SRB Management System the estimated econometric parameters are used to predict the effects of the Selective Reenlistment Bonus (SRB) on reenlistments. This is done by estimating the effect of a change from a baseline year, typically the year for which complete data is available that is nearest the prediction year. An alternative to the "baseline" method for predicting change is to predict directly from the estimated model, rather than as a change from the baseline.

The "baseline" method has the advantage of capturing fixed factors that are affecting reenlistment behavior in the baseline period and, presumably, the prediction period, but were not captured in the estimation. On the other hand, transient factors also affect reenlistment

rates. These factors, if transient, will not persist. In this case, predicting directly from the estimating equation, without regard to a difference from a baseline, is likely to provide more accurate predictions.

For a particular MOS, the estimation equation as applied to predict retention in year t is of the form[17]:

$$r(t) = \frac{1}{1 + e^{B_0 ACOL\ (t) + X\,(t) B}}$$

and

$$\ln\left(\frac{r(t)}{1-r(t)}\right) = B_0 ACOL(t) + BX(t).$$

If period t is the baseline, then r*(t) is the actual (realized) reenlistment rate for the MOS in year t. We make the period, t, the baseline for the model's prediction by solving for the value of a constant, a_0, so that the estimated reenlistment equation exactly predicts the actual reenlistment, r*(t), in baseline period t:

$$\ln\left(\frac{r^*(t)}{1-r^*(t)}\right) = B_0 ACOL(t) + a_0$$

Here, a_0 is a constant that encompasses BX(t) and other factors, not measured in the estimated reenlistment equation, that result in a difference between the predicted reenlistment rate r(t) and the actual or realized retention rate, r*(t), in the baseline period t. Solving for the constant, we have:

$$a_0 = \ln\left(\frac{r^*(t)}{1-r^*(t)}\right) - B_0 ACOL(t)$$

Then, substituting the value of a_0 into the previous equation, the prediction equation for year t+1, given that period t is the baseline, is:

$$r(t+1) = \frac{1}{1+e^{-[a_0 + B_0 ACOL(t+1)]}}$$

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[17] For expositional simplification, we suppress an MOS index.

This is equal to:

$$\ln\left(\frac{r(t+1)}{1-r(t+1)}\right)=\ln\left(\frac{r^*(t)}{1-r^*(t)}\right)+B_0[ACOL(t+1)-ACOL(t)]$$

Hence, if the ACOL value in period t+1 is the same as it is in the baseline period, the predicted reenlistment rate is the same as the baseline rate.[18] When the ACOL value in the prediction period differs from the baseline value, the predicted reenlistment rate differs, also.

If the estimated reenlistment equation is used to predict the reenlistment rate directly, the prediction is simply:

$$\ln\left[\frac{r(t+1)}{1-r(t+1)}\right]=B_0 ACOL(t+1)+BX(t+1)$$

B. Evidence

The empirical results presented earlier, particularly those in Tables 4 and 5, indicate that a variable that captures a shift in reenlistment behavior from FY 2001 through FY 2004 has a negative, statistically significant and quantitatively important effect during this period. Including this variable clearly improves predictions for the FY 2001-2004 period, compared to prediction from a model that does not include this shift variable.

This is indicated, for example, in Table 10. In Table 10, predictions for the hold-out samples in FY 2003 and FY 2004 are significantly better for the new model, which includes a shift dummy for the FY 2001 period and beyond, compared to the previous model estimated from the FY 1990-2000 data. This suggests a persistent, negative factor influencing reenlistment behavior from FY 2001.

However, had the "baseline" method been used to predict FY 2003 and FY 2004 by applying the equation from the previous model, it would have done better, as long as the "baseline" was FY 2001 or later. This is the primary advantage of the "baseline" approach. When equations are reestimated infrequently, and when the time-varying variables included are limited, so that they are not likely to capture changes such as deployment rates and so forth, the "baseline" approach is likely to be a way to improve predictions, as long as the baseline is a period near in time to the prediction period. If, on the other hand, a particular year is known to have idiosyncratic factors affecting reenlistment behavior that are not likely to be repeated, it is a poor candidate for use as a baseline year.

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[18] In principle, one could include other time-varying explanatory variables in the baseline approach to predicting future reenlistment rates, such as the unemployment rate of the mix of demographic characteristics. Then, if these values differ from the baseline value, the predicted reenlistment rate will differ from the baseline rate, in a manner similar to differences in the ACOL values between the prediction year and the baseline year.

In the ideal case, the basic reenlistment rate equation is well specified and captures most of the known time-varying factors that are likely to affect reenlistment rates currently and in the future. In practice, data that may capture a wide variety of factors that may affect reenlistment rates over time is difficult to obtain, or may not exist, in a way that permits estimation of useful parameters. In this case, which is closer to the practical world, the "baseline" approach is a useful substitute for frequent reestimation.

C. Logic for Selecting a Baseline Year in the Analysis Model

Given that that the baseline approach is appropriate, which period should be used for the baseline? The analysis must be based on a solid baseline year to help ensure predictive accuracy. An observed year that was subject to idiosyncratic behavior, on the other hand, will probably not yield good results.

In this section we describe a logic tree for evaluating candidate baseline periods and selecting the most promising for use as the model baseline. Figure 1 summarizes this decision process.

1. Start with the most recently observed baseline year

The search for a baseline year should begin with the most recent historical year. The main rationale for using the baseline approach is that it will adjust for unobserved factors that change over time and affect reenlistment behavior. Therefore, it is best to use a year as close as possible to the analysis year. If the most recent available year is not appropriate based on the other tests discussed below, the search should proceed backward in time.

When early work begins on a projection year $t + 1$ (e.g., in June or July of year t), the most recent year available may be year $t - 1$. After the execution year has begun, year t might be used instead.

2. Examine Army policies for comparability

Relevant policies should be compared between the candidate baseline year and the analysis year. If the Army has recently changed the eligibility rules for receiving an SRB, it would be better to use a baseline period with policies similar to those that will be used in the analysis year. This comparison does not need to extend to the SRB policies captured in the model, including bonus multiplier levels, lump-sum percentages and award ceilings.

3. Examine Army reenlistment policies for turbulence

For the candidate baseline year, were there any substantial changes in Army policies related to reenlistments? Recent examples include the change midway through FY 2005 in the length of the reenlistment eligibility window from 12 months to 24 months. FY 2005 would be a poor choice, because the new eligibility criteria were only in place for half of the year.

In summary, the ideal baseline year will have reenlistment-related policies identical to the analysis year and will have experienced little or no turbulence in those policies during the year.

4. *Assess SRB history for baseline year*

Turbulence in Army policy makes it difficult to establish a baseline; likewise, frequent within-year changes in the SRB plan for the baseline period may make for poor predictions. Recall that the adjustment of the reenlistment rates is based on the change in the Annualized Cost of Leaving (ACOL). To calculate this, the model calculates the ACOL for the baseline period and ACOL values for each potential SRB outcome in the projection period. The baseline ACOLs require the designation of a baseline SRB plan.

The ideal baseline year will have a single SRB plan (i.e., list of SRB multipliers by skill, zone and paygrade) for the entire fiscal year; in practice, this has not occurred in recent history for the Army. However, a year in which the plan changed two or three times will provide a more stable baseline than a year in which there were 15 to 20 SRB messages.

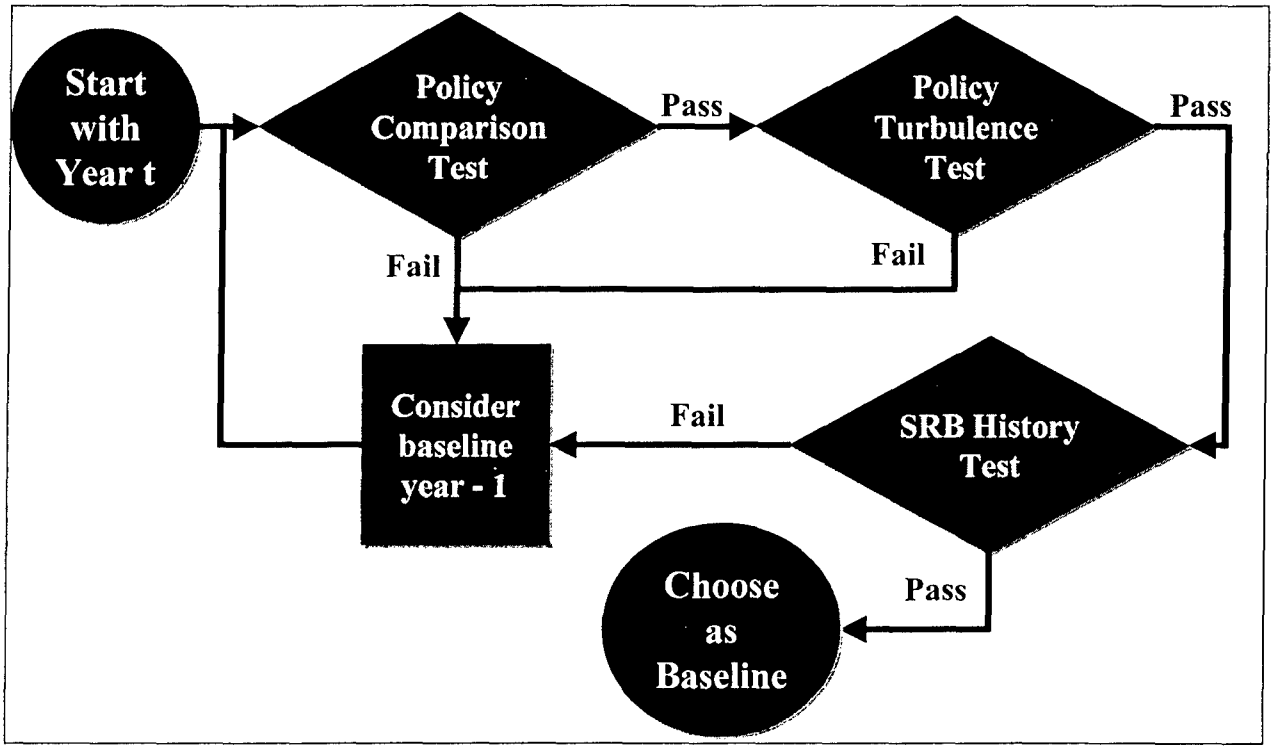

Figure 1. Baseline Year Selection Decision Tree

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